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Short and user-friendly: the development and validation of the Mini-DBQ

Laila M. Martinussen[a]*, Timo Lajunen[b], Mette Møller[a], Türker Özkan[b]

[a] DTU Transport, Bygningstorvet 116b, DK-2800 Kgs, Lyngby, Denmark

[b] Department of Psychology, Middle East Technical University (ODTÜ), Inonu Bulvari, 06531 Ankara, Turkey

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*Corresponding author. Tel. +45 45 25 65 00; fax: +45 45 93 65 33

E-mail address: laima@transport.dtu.dk (L. M. Martinussen)

Abstract

The Driver Behavior Questionnaire (DBQ) is used to measure aberrant driver behavior by asking drivers how often they engage in various aberrant driver behaviors. Since the development of the original DBQ, several modified versions have been developed. The difference between the various versions is that new items are added or existing items modified or excluded. However, despite the differences, all versions are relatively long and therefore time-consuming and tiring to answer, which might limit the usability of the instrument. The main purpose of the present study was to develop a mini DBQ version by reducing the 27-item original DBQ to the shortest possible DBQ version. A second aim was to explore the feasibility of a second-order structure within the data, which means that violations, errors and lapses factors load on a higher-order aberrant driver behavior factor. The presence of a second-order structure further indicates the validity of the DBQ and its theoretical structure. Confirmatory factor analysis (CFA) was used to test the fit (i.e., how well the models explain the data) of the original DBQ versus the fit of the shortest possible DBQ, as well as the presence of a second-order structure for the DBQ. The results identified a nine-item Mini-DBQ. In addition, a second-order structure was established in the data. These findings indicate that the Mini-DBQ is a valid and useful short measure of aberrant driver behavior.

Keywords; Driver Behaviour Questionnaire, Violations, Traffic safety, Risky driving

1. Introduction

The Driver Behaviour Questionnaire (DBQ) (Reason et al., 1990) is a self-report instrument used to assess how often drivers perform aberrant drivers behaviors in traffic. It measures three behavioral categories namely; violations, errors and lapses. The difference between these categories is that violations are deliberate acts, errors are acts that fail to get the intentional outcome, and lapses are unintentional acts. The DBQ has proved a useful tool for predicting self-reported accident involvement, which explains the frequent use of the questionnaire (de Winter and Dodou, 2010, report 174 studies using some version of the DBQ). Over the years, several versions of the DBQ have appeared based on studies applying the DBQ in varying situations and country-specific variations and solutions have been developed (see Özkan et al., 2006 for information on various DBQ versions). Most of these DBQ versions, however, are relatively long (for example; 104 items in the DBQ-SWE in Åberg and Rimmo, 1998; the original 50 items in the Manchester Driver Behaviour Questionnaire in Reason et al., 1990; and 27 in Lawton et al., 1997), and respondents are likely perceive them as time-consuming and tiring to answer (de Leeuw et al., 2008). Long questionnaires can lower the completion rate because participants find them overwhelming, or participants may decide not to answer the questionnaire at all if it looks too long (ibid.).This heightens the risk that people will refuse to participate in the study, leave out questions entirely or partly, or respond with biased or random answers. Moreover, the literature shows that people with a low educational level are less likely to participate in long surveys (Curtin et al., 2000; Groves et al., 2000; Kandel et al., 1983; Singer et al., 1999). To get an accurate picture of risky drivers, data from all social classes are needed, thus a shorter DBQ might help to increase the response rate among people with low educational qualifications. Furthermore, it would be useful to have a shorter version, which can capture aberrant driver behavior when time or other resources are limited. For instance, a short but valid questionnaire would reduce the expenses in postal surveys when the DBQ is a part of a test battery, applied to a large population, not to mention when it is used in road-side interviews. The shorter versions of the DBQ which have previously been used (Lawton et al., 1997; Özkan et al., 2006; Parker et al., 1995) apply a different factorial structure than the original DBQ, or are still quite long. The current study wanted to develop the shortest possible DBQ based on the original DBQ, as all versions have originated out of that. Since Reason et al. (1990) only reported items which had factor loadings above 0.50, 27 of the original 50 items are used as “the original DBQ” in the present paper (see Appendix for the 27-item DBQ).

When a shortened version of a questionnaire is being developed, it is crucial to establish validity and equivalence with the larger mother questionnaire, the original DBQ in this case. Two ways to achieve this are to compare the fit of the short DBQ and the longer DBQ with the empirical data using confirmatory factor analysis (CFA) and calculating the correlations between the factors in the longer and the shorter DBQ. It is crucial to establish high fit for the long and the suggested short version, because high fit in CFA indicates construct validity. High correlations between the same factors in the long and short DBQ indicate that they measure the same concepts to the same degree, and are thus also important.

Furthermore, since the DBQ consists of three factors that are supposed to measure aberrant driver behavior, the presence of a second-order structure, i.e., structural interrelations of the subscales (violations, errors and lapses loading on a higher-order aberrant driver behavior factor), also needs to be tested. This would give support for the further use of the DBQ and demonstrate its construct validity.

The first aim of this study was to develop a Mini-DBQ consisting of the highest loading items of Reason et al.'s (1990) original DBQ factor structure, and to compare the fit of the Mini-DBQ version against the original and longer DBQ version. The second aim of the study was to test whether a second-order factor structure, based on one second-order "aberrant driving" factor and three first order factors (violations, errors, lapses) could be established.

2. Method

2.1. Participants and procedure

A sample of 11,004 driving license (Danish type B for personal cars) holders was randomly selected from the Danish Driving License Register. The sample was stratified by age and gender to include 1,572 drivers in each of the following seven age groups; 18-24 years, 25-34 years, 35-44 years, 45-54 years, 55-64 years, 65-74 years, and 75-84 years (with 786 men and women in each age group). The DBQ with 50 items, a covering letter, and a freepost return envelope were sent by post to all the selected participants. A web address that the respondents could use for replies was also included. Two reminders were sent. The total response rate was 44.07 percent. Of the 4,849 responses (3780 mail-back, 1069 web-survey), 4,335 people returned a fully completed DBQ. Participants responded to the questionnaire anonymously. The Danish Data Protection Agency had approved the survey. Sample characteristics in presented in Table 1.

Table 1 about here

2.2. Measures

The Driver Behavior Questionnaire (Reason et al., 1990) was translated into Danish using the back-translation method, namely it is first translated into Danish, and then back to English again to assure similar meaning. The drivers were asked, using the standard DBQ instructions (see Reason et al., 1990), to indicate on a six-point Likert scale (0 = never and 5 = nearly all the time) how often they performed each of the 50 driving behaviors. Since the developers of the DBQ, Reason et al. (1990), reported only those items which had factor loadings above 0.50, only 27 of the original 50 items were used in the current study as “the original DBQ” (see Appendix for the 27-item DBQ version). Following the original structure, the driving behaviors included lapses, errors and violations. The items selected for the mini DBQ were the highest loading items in Reason et al.’s (1990) factor structure. A three item on each factor solution and a four item on each factor solution were selected to be tested. The rationale for having minimum three items per factor is that three items is the lowest number of items recommended for inclusion in exploratory factor analysis (Fabrigar et al., 1999), and the lowest suitable number of items for structural equation modeling (SEM). In SEM, less than three items can lead to both estimation problems and limited modeling flexibility (Little et al., 1999). Therefore, a nine-item and a twelve-item DBQ solution were compared and tested against the original DBQ with 27 items.

2.3. Statistical analysis

To cross-validate and assure that the fit is acceptable also in independent samples, the whole data set was split into two separate halves (named as Sample 1 and Sample 2) using the random split procedure in SPSS. Both samples were subjected to a CFA (LISREL with maximum likelihood estimation) to test the fit of Reason et al.'s (1990) nine highest loading DBQ items, Reason et al.'s (1990) twelve highest loading DBQ items, as well as Reason et al.'s (1990) original DBQ (see Russell, 2002, for detailed information on confirmatory factor analysis). Furthermore, the fit of the second-order structure was also tested using CFA (LISREL maximum likelihood estimation) on both data sets. The fit of these models was evaluated by the χ^2/degrees of freedom ratio, the root mean square error of approximation (RMSEA), the goodness-of-fit index (GFI), and the comparative fit index (CFI). Traditionally, a good fit model should have 2:1 or 5:1 χ^2/degrees of freedom ratio, GFI > 0.90, CFI > 0.90 (preferably > 0.95), and RMSEA < 0.08 or 0.10 (preferably < 0.05) indices (Hu and Bentler, 1999; Russell, 2002). Lastly, Cronbach's alpha values for the factors in the nine-item, the twelve-item and the original DBQ was calculated, as well as correlation between sum-scores of factors in the original DBQ and the short DBQ with the highest fit was carried out on the whole sample.

3. Results

3.1. Fit of the three DBQ versions

The fit indices of the first-order structures of the original DBQ, the nine-item and twelve-item DBQ were compared. The fit of all structures was tested in both samples separately. All items loaded only on one single factor. The goodness-of-fit indices suggest a satisfactory, though not perfect, fit for all structures (see Table 2). Overall, the goodness-of-fit indices show that the nine-item and the twelve-item DBQ structures had a better fit than the original DBQ structure, in both samples (see Table 2). Since the nine-item DBQ solution showed a slightly better fit than the twelve -item solution, the twelve-item solution was discarded, and therefore the Mini-DBQ in the rest of the paper refer to the nine-item solution.

The results also show that second-order structures were established in the empirical data. In the second-order structure, the goodness-of-fit indices for the nine-item DBQ and the twelve-item DBQ solutions and the original DBQ solution showed the same results as for both first-order structures (see Table 2). The factorial structures (both first-order and second-order structures) of the Mini-DBQ and the original DBQ tested with Sample 1 are schematically presented in Figures 1, 2, 3 and 4.

Table 2 about here

Figure 1, 2, 3, 4 about here

3.2. Reliability and inter-correlation for the Mini-DBQ and the original DBQ

Alpha values showed higher internal consistency for the original DBQ than for the Mini-DBQ (see Table 3). Acceptable high Cronbach's alpha is 0.7 and above (Cortina, 1993). Alpha values are affected by the number of items in each factor, thus an instrument like the Mini-DBQ will usually get low alpha values (Cortina, 1993). The twelve-item solution per factor did not show significantly higher alpha values than the nine-item DBQ, further supporting the use of the nine-item solution as the Mini-DBQ (violations; .605, errors; .638, lapses; .547 for twelve-item solution). Correlation between the sum-scores of the Mini-DBQ and the original DBQ is significant at a 0.01 level. The Mini-DBQ items are presented in Table 4.

Table 3 about here

Table 4 about here

4. Discussion

The purpose of the present study was to develop a shorter version of the DBQ by reducing the 27-item original DBQ (Reason et al., 1990) to a Mini-DBQ with as few items as possible. Two shorter versions of the original DBQ were tested. Results showed a better fit for a nine-item Mini-DBQ than for a twelve-item DBQ solution and the original 27-item DBQ. Moreover, a second-order structure was established empirically, thus supporting the further use of the DBQ, as well as demonstrating its construct validity.

The high fit of both the Mini-DBQ and the original to empirical data supports Reason et al.'s (1990) theory that violations, errors and lapses can be thought of as factors that measure aberrant driver behavior. The finding that the Mini-DBQ has better fit than the original DBQ in the current sample, indicates that the behaviors included in the Mini-DBQ are better at accounting for the variance, which shows that this set of questions capture the most important violations, errors, and lapses. Thus, the behavioral items included in the Mini-DBQ could be said to represent typical violation, error and lapse behaviors and can thus be labeled "core DBQ items". This is supported by the high correlation between the Mini-DBQ factors and the original DBQ factors, which shows that the two DBQ instruments measure the same concepts, despite the difference in the number of behavioral items included.

The fit indices were identical for both the first-order and the second-order structures. This is because a model with only three first-order factors is a 'just-identified' model, as it only includes three first-order factors and one second-order factor (Chen et al., 2005; Rindskopf and Rose, 1988). An exception to just-identified models is the case when one or more of the first-order factors have nothing in common with one or more of the other first-order factors (Rindskopf and Rose, 1988). However, this is not the case in the DBQ. Rindskopf and Rose (1988) recommend including at least four first-order factors, but this could not be done in the current study, because the original DBQ consists of only three factors designed to measure aberrant driver behavior. Since the original DBQ is the one from which all later versions are derived, it seemed reasonable that a shorter DBQ should have the same structure, i.e., three factors, as in the original. Furthermore, for the methodological reasons aforementioned, minimum three items per factor were used. However, when fewer items are used, some reduction in reliability coefficients is normal. The alpha values for the original DBQ factors were higher than for the Mini-DBQ factors, because alpha reliability depends on the number of the items as well as their quality (Cortina, 1993). Alpha values did not become significantly higher with the twelve-item DBQ, supporting the use of the shortest possible, nine-item Mini-DBQ. Low alpha values are something researchers either have to tolerate or weigh up against its practical value, when using a shorter instrument like the Mini-DBQ.

Moreover, when a short form of a measurement tool is developed, it is crucial to test its applicability in other samples (Smith et al., 2000), so further testing of the Mini-DBQ is recommended. Earlier research has shown that the DBQ structure is stable across cultures (Lajunen et al., 2004) and across time (Özkan et al., 2006). The high correlation between the Mini-DBQ and the original DBQ factors means that a similar stability across cultures and time could be expected of the Mini-DBQ. However, this assumption needs to be tested by future studies using the Mini-DBQ. Since the DBQ was developed, the use of smart phones and other in-vehicle devices has become normal driving behaviors for many drivers. As these devices may distract drivers, and thereby lead to hazardous driving items measuring for example telephone use have been suggested as possible additions to the DBQ (Freeman et al., 2007). Such additions could be a useful addition to the Mini-DBQ in the future. Lastly, previous research has demonstrated that for some groups, some components of the DBQ predict on road issues, such as accidents, better than others (de Winter and Dodou, 2010; Parker et al., 2000). Therefore the applicability of the Mini-DBQ should also be tested in sub-groups of drivers. In conclusion, with relatively few items, the Mini-DBQ can be used to assess aberrant driver behavior instead of the full DBQ when a quick measure of aberrant driver behavior is needed.

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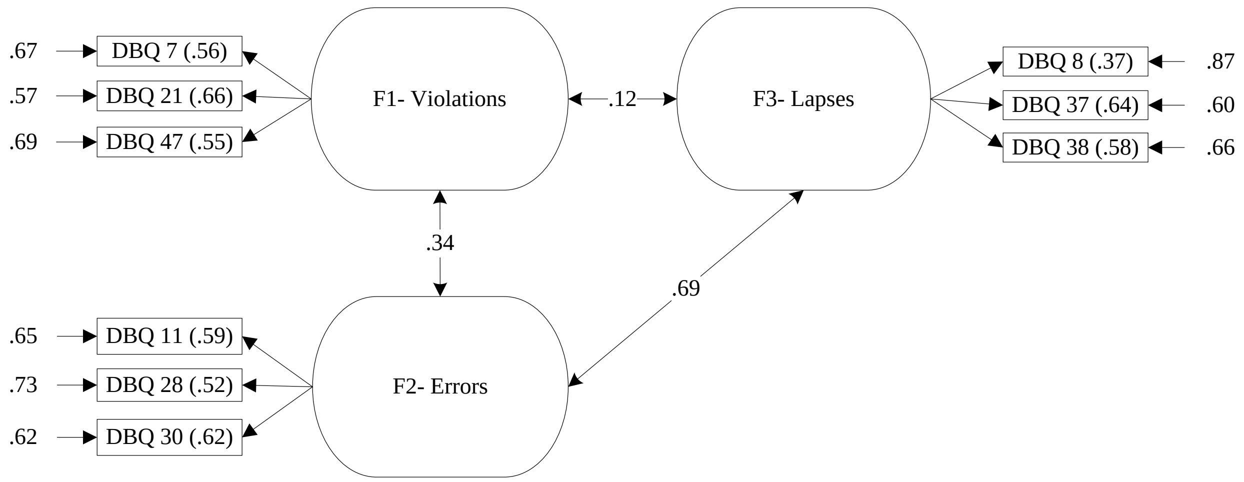

Figure 1. First-order Mini-DBQ structure
The figure shows factor loadings (inside boxes) and error measures (outside boxes) for all items

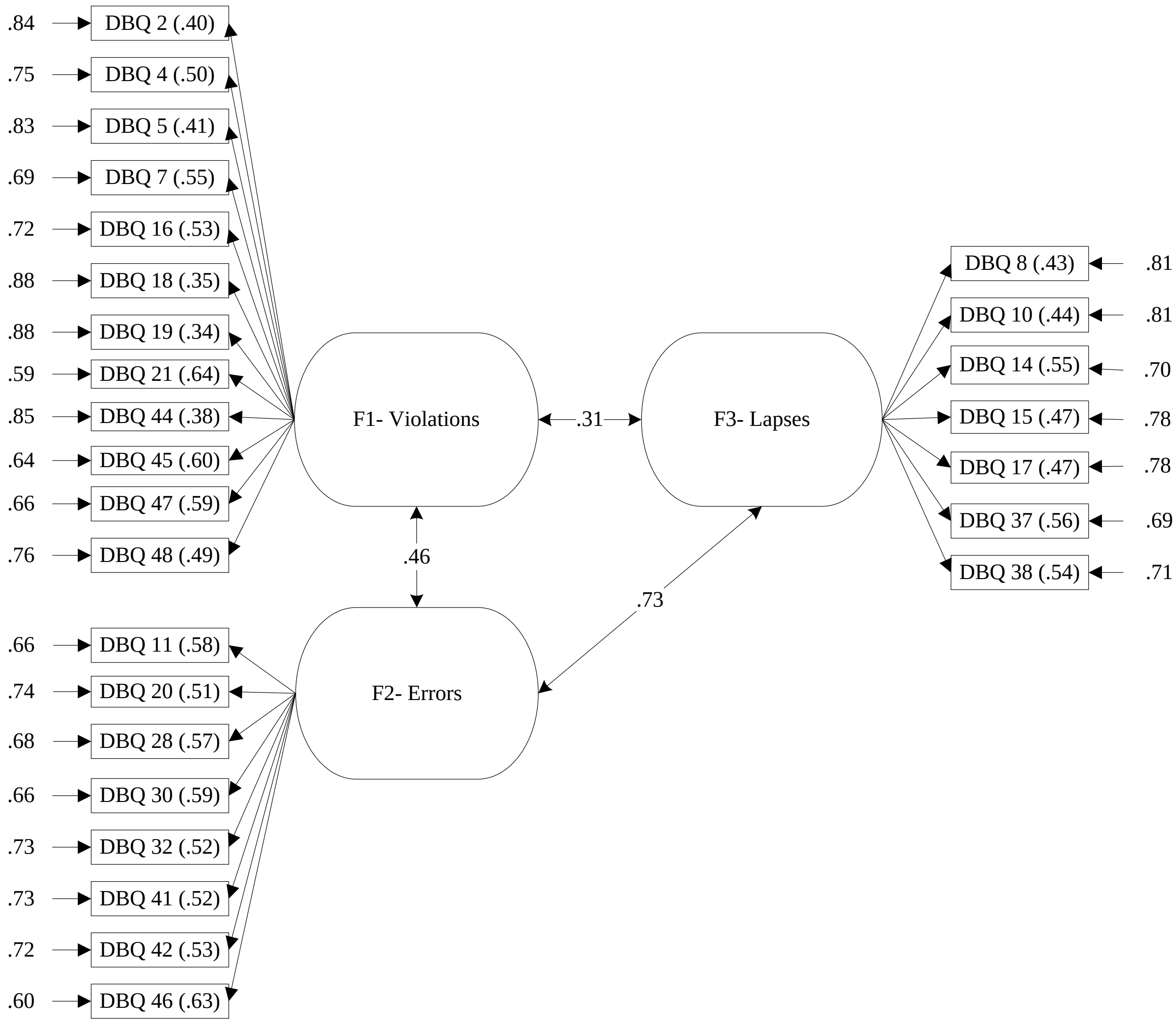

Figure 2. First-order original DBQ structure
The figure shows factor loadings (inside boxes) and error measures (outside boxes) for all items

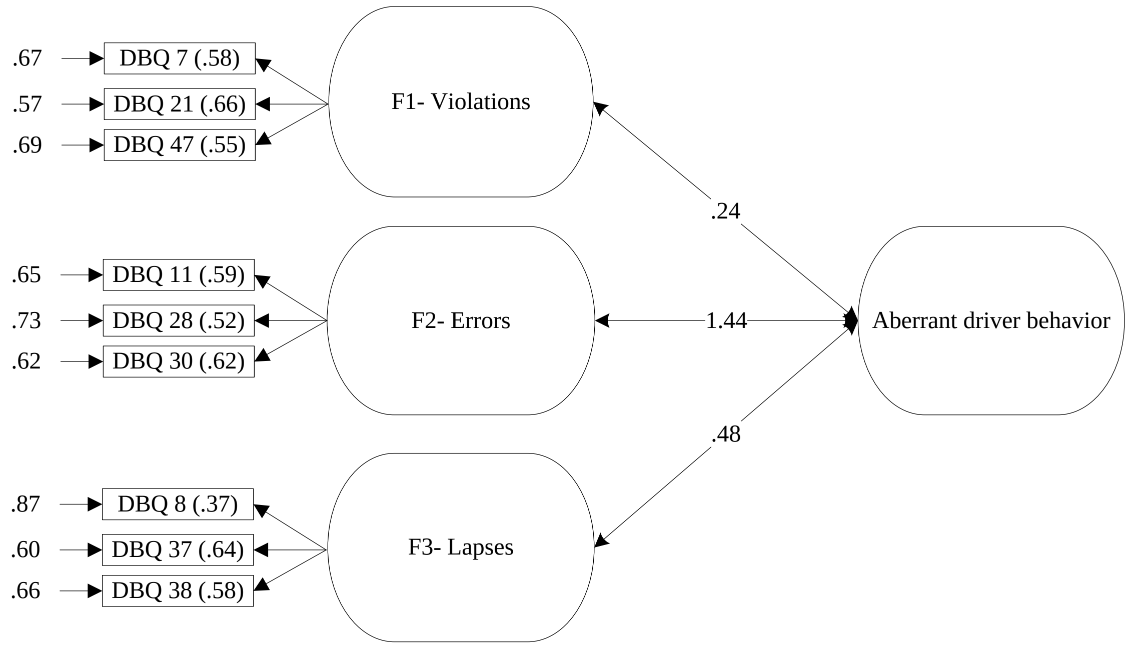

Figure 3. Second-order Mini-DBQ structure
The figure shows factor loadings (inside boxes) and error measures (outside boxes) for all items

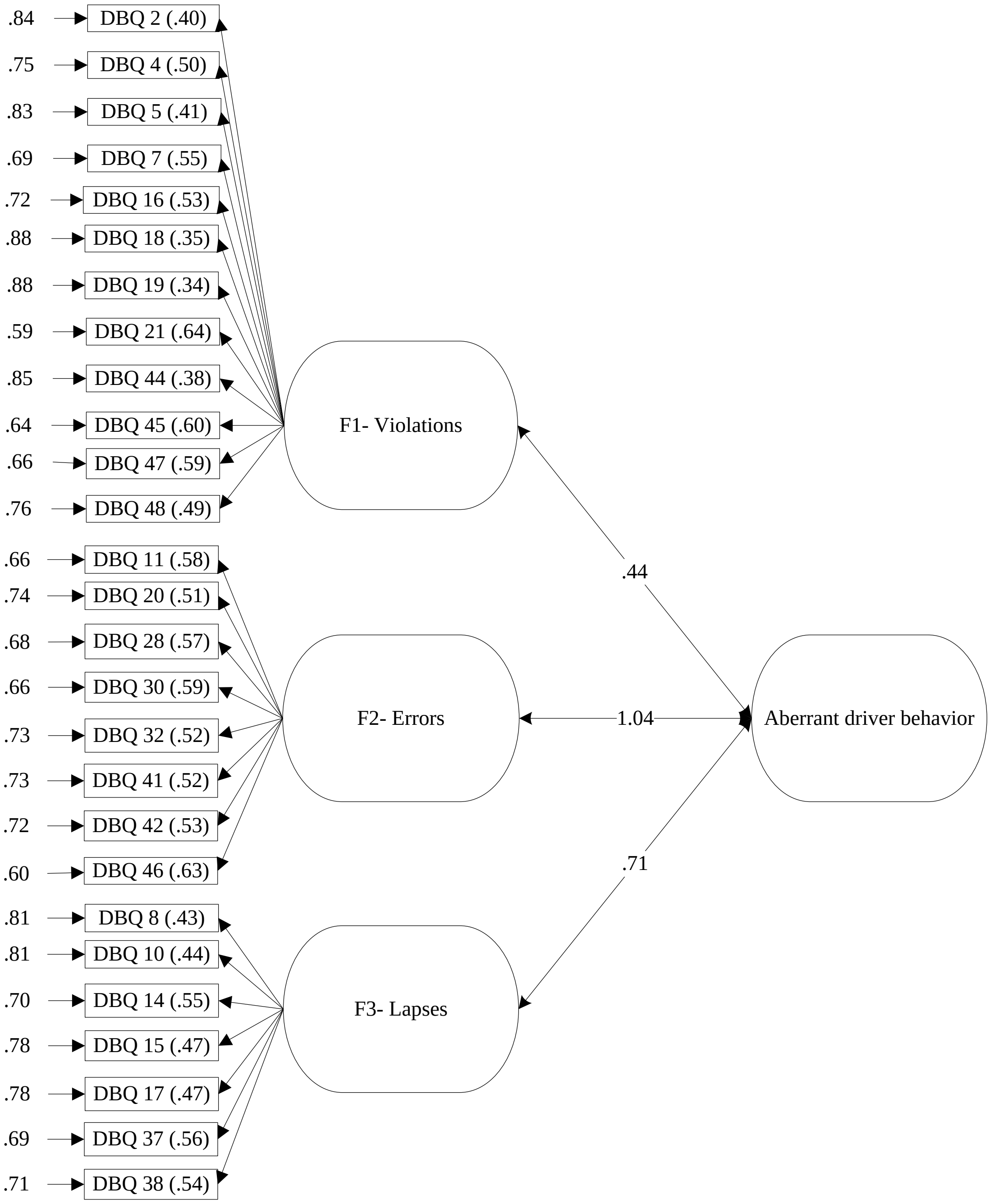

Figure 4. Second-order original DBQ structure

The figure shows factor loadings (inside boxes) and error measures (outside boxes) for all items

Table 1. Sample characteristics

	Total	Males	Females

N	4335	2204	2131
Age			
Mean	50.9	53.25	48.5
St. D	18.89	19.05	18.42

Table 2
Fit indices from confirmatory factor analysis in both samples

First-order nine-item Mini-DBQ		
	First half of sample, N = 2110	*Second half of sample, N = 2156*
CFI	.981	.984
GFI	.993	.994
RMSEA	.0292	.0276
χ^2/df	67.26/24	63.37/24
Ratio	2.802	2.640
First-order twelve-item solution		
	First half of sample, N = 2110	*Second half of sample, N = 2156*
CFI	.949	.952
GFI	.982	.988
RMSEA	.041	.040
χ^2/df	227.99/51	223.47/51
Ratio	4.470	4.381
First-order original DBQ		
	First half of sample, N = 2110	*Second half of sample, N = 2156*
CFI	.860	.867
GFI	.936	.939
RMSEA	.0491	.0476
χ^2/df	1951.66/321	1889.25/321
Ratio	6.079	5.885
Second-order nine-item Mini-DBQ		
	First half of sample, N = 2110	*Second half of sample, N = 2156*
CFI	.981	.984
GFI	.993	.994
RMSEA	.0292	.0276
χ^2/df	67.26/24	63.37/24
Ratio	2.802	2.640
Second-order twelve-item solution		
	First half of the sample, N = 2110	*Second half of the sample, N = 2156*
CFI	.949	.952
GFI	.982	.983
RMSEA	.041	.040
χ^2/df	277.99/51	223.47/51

Ratio	4.470	4.381
Ratio	Second-order original DBQ	
	First half of sample, N = 2110	*Second half of sample, N = 2156*
CFI	.860	.867
GFI	.936	.939
RMSEA	.0491	.0476
χ^2/df	1951.66/321	1889.25/321
Ratio	6.079	5.885

Note: Criteria for a good fit are 2:1 or 5:1 χ^2/df, GFI > 0.90, CFI > 0.90, and RMSEA <0.05

Table 3
Alpha values, and correlations between factors in Mini-DBQ and original DBQ

	Mini-DBQ Violations	*Mini-DBQ Errors*	*Mini-DBQ Lapses*	*Original Violations*	*Original Errors*	*Original Lapses*
Mini-DBQ Violations	**1**	.224	.118	.849	.245	.149
Mini-DBQ Errors	.224	**1**	.402	.333	.870	.470
Mini-DBQ Lapses	.118	.402	**1**	.196	.456	.833
Original Violations	.849	.333	.196	**1**	.358	.255
Original Errors	.245	.870	.456	.358	**1**	.516
Original Lapses	.149	.470	.833	.255	.516	**1**
Alpha values	.549	.577	.493	.735	.769	.679

Table 4
Mini-DBQ items

	Original DBQ item numbers	
V*	7	Driving especially close or “flashing” the car in front as a signal for that driver to go faster or get out of your way
V	21	Deliberately disregarding the speed limits late at night or very early in the morning
V	47	Getting involved in unofficial “races” with other car drivers
E*	11	Turning right on to a main road into the path of an oncoming vehicle that you had not seen,

		or whose speed you had misjudged
E	28	Failing to notice, because lost in thought or distracted, someone waiting at a zebra crossing, or that a pelican crossing light has just turned red
E	30	Misjudging the speed of a moving vehicle when overtaking
L*	8	Forgetting where you left your car in a multi-level car park
L	37	Getting into the wrong lane at a roundabout or approaching a road junction
L	38	Failing to read the signs correctly, and exiting from a roundabout on the wrong road

* V=Violations, E=Errors, L=Lapses